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Original Article

Effect of Sedentary Behavior on the Nutritional Status of Children (Age Between 6 to 12 Years)

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ABSTRACT

Background: Sedentary behavior, prolonged screen exposure, inadequate physical activity, and unhealthy dietary practices are increasingly associated with abnormal nutritional status among school-aged children. In urban settings such as Karachi, these behaviors may contribute to both excess body weight and broader nutritional imbalance. Objective: To assess the association between sedentary behavior and nutritional status among children aged 6–12 years in Karachi, Pakistan. Methods: This school-based cross-sectional study included 380 children aged 6–12 years from selected public and private schools in Karachi. Data were collected using a structured parent-completed questionnaire assessing sociodemographic characteristics, dietary behaviors, physical activity, sedentary behavior, screen time, sports participation, and transport mode. Height and weight were measured using standardized procedures, and nutritional status was classified using WHO BMI-for-age Z-score categories. Data were analyzed using SPSS version 23. Frequencies and percentages were calculated, and chi-square tests were used to assess associations between categorical variables and BMI-based nutritional status. Results: Of 380 children, 201 were male and 179 were female. Overall, 43 children were underweight, 124 had normal weight, 79 were overweight, and 134 were obese. Combined overweight/obesity was present in 213 children. Weekday sedentary behavior, recreational screen time >2 hours/day, physical activity category, breakfast frequency, dinner frequency, fast-food and snack intake, delayed meal pattern, and transport mode were significantly associated with BMI-based nutritional status. Screen time >2 hours/day showed the clearest association with overweight/obesity, as 170 of 195 children in this category were overweight or obese compared with 43 of 185 children with screen time ≤2 hours/day. Conclusion: Sedentary behavior, prolonged recreational screen time, dietary patterns, and physical activity category were significantly associated with nutritional status among children aged 6–12 years in Karachi. Because of the cross-sectional design, the findings should be interpreted as associations rather than causal effects. School- and family-based interventions should prioritize reducing recreational screen exposure, promoting regular physical activity, and improving dietary routines. Keywords: Sedentary behavior; nutritional status; obesity; overweight; physical activity; screen time; children; BMI-for-age

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INTRODUCTION

A healthy nutritional status during childhood is essential for physical growth, cognitive development, immune function, psychosocial well-being, and long-term prevention of non-communicable diseases. In school-aged children, nutritional status is influenced by a complex interaction of dietary intake, physical activity, sedentary behavior, sleep patterns, socioeconomic conditions, parental education, and the surrounding home and school environment. Inappropriate dietary practices and insufficient physical

activity are increasingly recognized as modifiable behavioral factors associated with both undernutrition and excess body weight, particularly in urban settings where lifestyle transitions have altered children's daily routines (1). Sedentary behavior is commonly defined as any waking behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents while sitting, reclining, or lying. It includes television viewing, mobile phone use, computer use, video gaming, reading, and other seated activities that may displace active play and reduce total daily energy expenditure (2–4).

Childhood sedentary behavior has become an important public-health concern because many children spend a substantial proportion of their waking hours in low-energy activities. Higher sedentary exposure has been associated with obesity, poor cardiometabolic profiles, psychosocial difficulties, reduced health-related quality of life, and lower physical fitness among children and adolescents (5,6). At the same time, adequate physical activity remains an important component of healthy growth and weight regulation. The World Health Organization recommends that children and adolescents aged 5–17 years should engage in an average of at least 60 minutes per day of moderate-to-vigorous physical activity and should limit prolonged sedentary time, particularly recreational screen exposure (7). However, many children do not meet these recommendations, especially in urban environments where academic pressure, screen-based entertainment, motorized transport, safety concerns, and reduced access to outdoor play spaces may encourage inactive routines.

The nutritional consequences of sedentary behavior are particularly relevant in low- and middle-income countries, where the double burden of malnutrition is increasingly evident. Pakistan continues to face undernutrition while also experiencing a rise in overweight and obesity among school-aged children, especially in urban populations undergoing dietary and lifestyle transition (6,7). This coexistence of underweight, normal weight, overweight, and obesity within the same pediatric population requires assessment through age-appropriate anthropometric indicators. Unlike adults, children should not be classified using adult BMI cutoffs alone; BMI-for-age Z-scores or percentile-based references are required to interpret nutritional status according to age and sex. Therefore, clearly defining the reference standard used for BMI-for-age classification, such as WHO, CDC, or IOTF criteria, is essential for interpreting the prevalence of overweight and obesity and for comparing findings across studies.

Previous studies from Pakistan and other settings have reported associations of overweight and obesity with dietary behaviors, physical inactivity, sedentary lifestyle, fast-food intake, screen exposure, breakfast skipping, and sociodemographic characteristics among school-aged children (8–10). However, findings have not always been consistent across age groups, sexes, and populations. Some studies have shown strong associations between screen time and excess body weight, whereas others have reported weak or non-significant relationships, suggesting that the association may be influenced by local context, dietary habits, activity patterns, socioeconomic status, and parental behaviors (11). Similarly, physical activity may not show a simple linear relationship with nutritional status in cross-sectional data because heavier children may still report participation in activity, and activity duration alone may not reflect intensity, regularity, or total energy balance.

In Karachi, rapid urbanization, increasing availability of energy-dense foods, widespread use of digital devices, reliance on motorized transport, and limited opportunities for safe outdoor activity may contribute to sedentary routines and unhealthy dietary patterns among children. At the same time, undernutrition remains a continuing public-health concern in Pakistan, making it necessary to evaluate the full spectrum of nutritional status rather than focusing only on overweight and obesity (12–14). Early identification of modifiable behavioral and environmental factors is important because dietary and activity patterns established during childhood may continue into adolescence and adulthood, increasing the future risk of obesity and non-communicable diseases (15).

The present study was therefore conducted to assess the association between sedentary behavior and nutritional status among school-going children aged 6–12 years in Karachi, Pakistan. The study focused on sedentary behavior, recreational screen time, physical activity, dietary practices, sports participation,

transport mode, and sociodemographic factors in relation to BMI-for-age nutritional categories. Because of the cross-sectional design, the study does not establish causality; rather, it identifies behavioral and sociodemographic correlates of abnormal nutritional status that may guide future school- and family-based preventive interventions.

MATERIALS AND METHODS

This school-based cross-sectional observational study was conducted among children aged 6–12 years enrolled in selected public and private schools in Karachi, Pakistan. The study was carried out over one year, from September 2022 to September 2023, while field data collection was completed during prearranged school visits in February 2023. The study was designed to assess the association between sedentary behavior and nutritional status; therefore, no causal effect was inferred from the findings.

The target population consisted of school-going children aged 6–12 years. Children present on the day of data collection and falling within the required age range were eligible for inclusion. Children were excluded if parental consent was not provided or if they had chronic diseases, diagnosed mental illness, eating disorders, metabolic disorders, or any condition likely to independently affect body weight, dietary behavior, physical activity, or BMI-based nutritional classification. Participants were recruited using a non-probability convenience sampling technique from participating schools after administrative permission had been obtained.

The sample size was calculated using CDC Epi Info sample size calculator version 5.5.11, with a 95% confidence level and 5% margin of error. Based on an estimated prevalence of 61.2% from previous literature, the minimum required sample size was 365. To compensate for possible non-response or incomplete data, an additional 5–10% was added, giving a final sample of 380 children.

Data were collected using a structured, closed-ended parent-completed questionnaire, an electronic weighing scale, and a standard height-measuring scale. The questionnaire included an informed consent statement and was distributed to parents through the children's school diaries along with an official notice explaining the purpose of the study. Parents completed the questionnaire at home and returned it through class teachers, who handed the completed forms to the research team.

The questionnaire included three main sections. The first section assessed sociodemographic variables, including age, sex, class, father's education, mother's education, parental working status, household income, and residential area. The second section assessed dietary behaviors, including breakfast frequency, lunch at home, dinner frequency, fast-food and snack consumption, meal patterns, and delayed meals. The third section assessed activity-related variables, including mode of transport to school, participation in sports, type of free-time activity, duration of moderate-to-vigorous physical activity, screen time, indoor and outdoor games, sedentary behavior, and sleep-related routine.

Sedentary behavior was assessed as daily time spent in low-movement activities outside school hours, including television viewing, mobile phone or computer use, video gaming, reading, and other seated activities. Recreational screen time was categorized as ≤2 hours/day and >2 hours/day, excluding screen time required for schoolwork. Physical activity was categorized according to the reported daily duration of moderate-to-vigorous activity, including brisk walking, jogging, cycling, swimming, sports, aerobic exercise, and active play.

Anthropometric measurements were obtained using standardized procedures. Weight was measured in kilograms using an electronic weighing scale and recorded to the nearest 0.1 kg. Height was measured in centimeters using a standard height scale and recorded to the nearest 0.5 cm. Instruments were standardized before measurement, and weighing scales were calibrated to zero before use. Body mass index was calculated as weight in kilograms divided by height in meters squared. Nutritional status was classified using age- and sex-specific BMI-for-age Z-score categories according to WHO growth reference standards as underweight, normal weight, overweight, and obese. The main outcome variable was BMI-

for-age nutritional status, and for selected analyses overweight and obesity were combined as a binary outcome.

Data were entered, cleaned, coded, and analyzed using SPSS version 23. Descriptive statistics were calculated for all study variables. Categorical variables were summarized as frequencies and percentages. The chi-square test was used to assess associations between categorical exposure variables and BMI-based nutritional status. Variables assessed included sedentary behavior, screen time, physical activity, breakfast frequency, lunch at home, dinner frequency, fast-food and snack consumption, delayed meal patterns, sports participation, transport mode, parental education, household income, age, and sex. A p-value of ≤0.05 was considered statistically significant. Because the study used a cross-sectional design, associations were interpreted cautiously and were not presented as evidence of causation. Where possible, findings were described as associations with BMI-based nutritional status rather than effects.

Ethical approval was obtained from the Ethical Review Committee of Bahria University Health Sciences. Permission was obtained from participating school administrations before data collection. Parents or guardians were informed about the study through the consent statement attached to the questionnaire, and participation was voluntary. Confidentiality of participant information was maintained throughout data collection, entry, analysis, and reporting.

RESULTS

A total of 380 children aged 6–12 years were included in the analysis. Of these, 201 were male and 179 were female. Based on BMI-for-age Z-score classification, 43 children were underweight, 124 had normal weight, 79 were overweight, and 134 were obese. The combined frequency of overweight and obesity was 213 children, representing 56.1% of the sample. Obesity was more frequent among males, while overweight was slightly more frequent among females, and the sex-wise distribution of BMI categories was statistically significant (p = 0.030).

Table 1. Baseline Characteristics and Nutritional Status of Children Aged 6–12 Years

Variable	Frequency, n	Percentage, %
Total sample	380	100.0
Male	201	52.9
Female	179	47.1
Underweight	43	11.3
Normal weight	124	32.6
Overweight	79	20.8
Obese	134	35.3
Combined overweight/obesity	213	56.1

Physical activity was significantly associated with BMI-based nutritional status (χ^2 = 19.728, p = 0.020). However, the distribution did not show a simple protective pattern because the largest number of overweight and obese children was also found in the group reporting more than 60 minutes of physical activity per day. This may reflect the larger size of this activity category or possible differences in activity intensity, reporting accuracy, or total energy intake. Therefore, physical activity should be interpreted as statistically associated with nutritional status rather than independently protective in this unadjusted analysis. Weekday sedentary behavior was also significantly associated with BMI category (χ^2 = 23.339, p = 0.025), whereas weekend sedentary behavior was not significantly associated with BMI category (χ^2 = 9.132, p = 0.692).

Table 2. Physical Activity and Sedentary Behavior According to BMI Category

Variable	Underweight n=43	Normal n=124	Overweight n=79	Obese n=134	χ^2	p-value
Physical activity					19.728	0.020
None	9	29	14	22		
<30 minutes/day	3	5	13	19		
30–60 minutes/day	2	9	11	20		
>60 minutes/day	29	81	41	73		

Variable	Underweight n=43	Normal n=124	Overweight n=79	Obese n=134	χ^2	p-value
Sedentary behavior on weekdays					23.339	0.025
Half–1 hour/day	24	39	28	59		
2 hours/day	12	45	25	29		
3 hours/day	3	24	7	24		
4 hours/day	3	9	9	13		
>4 hours/day	1	7	10	9		
Sedentary behavior on weekends					9.132	0.692
Half–1 hour/day	18	34	30	41		
2 hours/day	14	31	20	34		
3 hours/day	6	27	14	25		
4 hours/day	3	21	9	20		
>4 hours/day	2	11	6	14		

Dietary behaviors also showed significant associations with BMI-based nutritional status. Breakfast frequency was significantly associated with BMI category ($\chi^2 = 22.699$, $p = 0.030$). Among children who never consumed breakfast, 18 were overweight and 24 were obese. Lunch at home was not significantly associated with BMI category ($\chi^2 = 17.558$, $p = 0.130$). Dinner frequency showed a significant association with BMI status ($\chi^2 = 27.649$, $p = 0.006$), and fast-food/snack consumption was also significantly associated with BMI category ($\chi^2 = 26.619$, $p = 0.009$).

Table 3. Dietary Behaviors According to BMI Category

Dietary Variable	Underweight n=43	Normal n=124	Overweight n=79	Obese n=134	χ^2	p-value
Breakfast frequency					22.699	0.030
Never	5	10	18	24		
Once/month	1	7	4	2		
Once/week	5	11	1	6		
2–4 days/week	18	42	32	51		
5–7 days/week	14	54	24	51		
Lunch at home					17.558	0.130
Never	5	5	3	3		
Once/month	1	3	0	4		
Once/week	1	9	4	3		
2–4 days/week	13	25	18	25		
5–7 days/week	23	82	54	99		
Dinner frequency					27.649	0.006
Never	3	0	0	1		
Once/month	0	1	0	1		
Once/week	1	7	1	2		
2–4 days/week	10	13	13	18		
5–7 days/week	29	103	65	112		
Fast food and snacks					26.619	0.009
Never	3	2	0	0		
Once/month	8	13	14	25		
Once/week	12	41	32	47		
2–4 days/week	15	32	18	39		
5–7 days/week	5	36	15	23		

When specific sedentary-behavior criteria were examined, recreational screen time greater than 2 hours per day showed the strongest association with overweight/obesity ($p < 0.001$). Among children with screen time >2 hours/day, 170 of 195 children were overweight or obese, compared with 43 of 185 children with screen time ≤2 hours/day. Moderate-to-vigorous physical activity was also associated with overweight/obesity ($p = 0.020$). Breakfast frequency was significantly associated with overweight/obesity ($p = 0.030$). Delayed meals eaten above planned limits showed a statistically significant association ($p = 0.003$), but the direction of the association was opposite to the expected interpretation: overweight/obesity was more frequent among children who reported no delayed meals than among those who reported delayed meals. This variable should therefore be reported cautiously and should not be described as a positive predictor of overweight/obesity without further verification.

Table 4. Sedentary-Behavior Criteria and Association With Overweight/Obesity

Criterion	Total n=380	Overweight n=79	Obese n=134	Combined n=213	p-value
Screen time >2 hours/day					<0.001
Yes	195	59	111	170	
No	185	20	23	43	
Moderate-to-vigorous physical activity/day					0.020
None	74	14	22	36	
1–30 minutes	40	13	19	32	
31–60 minutes	42	11	20	31	
>60 minutes	224	41	73	114	
Breakfast frequency					0.030
Never	58	18	24	42	
Once/month	13	4	2	6	
Once/week	23	1	6	7	
2–4 days/week	147	32	51	83	
5–7 days/week	139	24	51	75	
Delayed meals eaten above planned limits					0.003
Yes	207	27	28	55	
No	173	52	106	158	

Sociodemographic characteristics were associated with selected lifestyle behaviors. Age was significantly associated with sports participation and fast-food/snack consumption more than once weekly. Father's education and mother's education were significantly associated with both sports participation and frequent fast-food/snack consumption. Household income was significantly associated with frequent fast-food/snack consumption, and mode of transport was significantly associated with both sports participation and fast-food/snack consumption. Motor transport was the most common mode of school travel.

Overall, the results showed that overweight and obesity were common in this sample of school-going children aged 6–12 years. Screen time greater than 2 hours per day showed the clearest association with overweight/obesity. Weekday sedentary behavior, breakfast frequency, dinner frequency, fast-food/snack consumption, physical activity level, and delayed meal pattern were also statistically associated with BMI-based nutritional status. However, because the analysis was based mainly on chi-square testing, these findings should be interpreted as unadjusted associations. Multivariable regression would be needed to determine whether screen time, physical activity, dietary behaviors, and sociodemographic variables remain independently associated with overweight/obesity after adjustment for potential confounders.

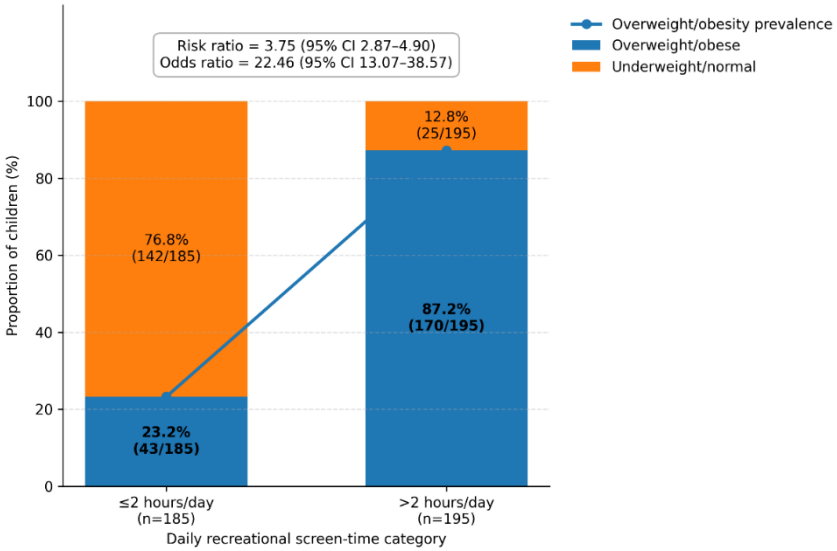

Figure 1. Screen-Time Exposure and Overweight/Obesity Burden Among

Among children with recreational screen time of >2 hours/day, 170 of 195 children were overweight or obese, corresponding to a prevalence of 87.2%, compared with 43 of 185 children, or 23.2%, among those with screen time of ≤2 hours/day. The derived risk ratio was 3.75, with a 95% confidence interval of 2.87–4.90, indicating that children exceeding 2 hours of daily screen exposure had nearly four times the prevalence of overweight/obesity compared with children within the lower screen-time category. The corresponding odds ratio was 22.46, with a 95% confidence interval of 13.07–38.57, reflecting a steep adverse nutritional-status gradient across recreational screen-time exposure categories. This pattern demonstrates a clinically meaningful concentration of excess body weight among children with prolonged screen exposure, supporting screen time as one of the strongest behavioral correlates of overweight and obesity in this cohort.

DISCUSSION

The present school-based cross-sectional study found a high burden of abnormal nutritional status among children aged 6–12 years in Karachi, with more than half of the participants classified as overweight or obese according to BMI-for-age Z-score categories. This finding indicates that excess body weight is an important concern in this sample; however, the magnitude of overweight/obesity should be interpreted cautiously because it depends strongly on the anthropometric reference standard used for classification. For pediatric populations, BMI must be interpreted according to age- and sex-specific references rather than adult BMI cutoffs. Therefore, the use of WHO BMI-for-age Z-score criteria should be clearly retained in the Methods and Results sections to support the validity and comparability of the reported prevalence.

Sedentary behavior showed a significant association with BMI-based nutritional status, particularly weekday sedentary behavior and recreational screen time exceeding 2 hours per day. Children with screen time >2 hours/day had a substantially higher proportion of overweight/obesity than children with screen time ≤2 hours/day. This finding is consistent with the biological plausibility that prolonged screen exposure may reduce time available for active play, increase total sedentary time, promote snacking, and increase exposure to advertisements for energy-dense foods. Similar associations between sedentary behavior, screen exposure, and excess adiposity have been reported in previous pediatric studies, although findings vary across populations because screen use interacts with dietary habits, physical activity, sleep, family routines, and socioeconomic factors (4,5,17,22).

Physical activity was significantly associated with nutritional status, but the direction of this association should be interpreted with caution. Although children reporting no or limited moderate-to-vigorous physical activity had a notable burden of overweight/obesity, the largest absolute number of overweight and obese children was also present in the group reporting >60 minutes/day of activity. This may reflect the larger size of that activity category, self-reporting bias, variation in activity intensity, compensatory eating, or residual confounding by age, sex, diet, and household factors. Therefore, the present findings support an association between physical activity category and BMI status but should not be overstated as proof that physical activity independently protected against overweight or obesity in this unadjusted cross-sectional analysis. Multivariable modelling would be required to clarify whether physical activity remains independently associated with overweight/obesity after controlling for screen time, dietary behaviors, sex, age, parental education, household income, and transport mode.

Dietary behaviors were also associated with nutritional status. Breakfast frequency, dinner frequency, and fast-food/snack consumption showed statistically significant associations with BMI categories. Children who never consumed breakfast had a high proportion of overweight and obesity, supporting previous evidence that irregular breakfast intake may be linked with higher adiposity, altered appetite regulation, increased snacking, and lower activity levels (23). Fast-food and snack consumption was also significantly associated with BMI status, which is consistent with the role of energy-dense, nutrient-poor

foods in childhood weight gain. However, as dietary intake was parent-reported and frequency-based, the findings cannot determine total caloric intake, portion size, nutrient quality, or temporal sequence.

The finding for delayed meals requires particular caution. Although delayed meals eaten above planned limits showed a statistically significant association with BMI status, the observed distribution suggests that overweight/obesity was higher among children who reported no delayed meals than among those who reported delayed meals. This is opposite to the expected interpretation and should not be described as a positive predictor of overweight/obesity without rechecking coding, category labels, and data entry. The safest interpretation is that delayed meal pattern was statistically associated with BMI category, but the direction and meaning of the association require verification before drawing any nutritional conclusion.

Sociodemographic factors were associated with lifestyle behaviors, including sports participation and fast-food/snack consumption. Parental education, household income, and transport mode may influence children's access to organized sports, recreational screen devices, fast food, and motorized transport. Most children used motor transport for school travel, which may reduce incidental physical activity from walking or cycling. However, these variables may also confound each other; for example, higher-income households may have greater access to both structured sports and energy-dense foods. Because only chi-square tests were used, the study cannot separate independent associations from confounded relationships.

The study has several limitations. First, the cross-sectional design prevents causal inference; therefore, the findings should be interpreted as associations rather than effects. Second, sedentary behavior, screen time, physical activity, and dietary behaviors were parent-reported, which may introduce recall bias and social desirability bias. Third, convenience sampling from selected schools limits generalizability to all children in Karachi. Fourth, the statistical analysis was limited mainly to chi-square testing; multivariable logistic regression would strengthen the analysis by identifying independent predictors of overweight/obesity. Despite these limitations, the study provides useful local evidence on the clustering of screen exposure, sedentary behavior, dietary practices, transport mode, and BMI-based nutritional status among school-aged children in Karachi.

CONCLUSION

Overweight and obesity were common among school-going children aged 6–12 years in Karachi in this cross-sectional study. BMI-based nutritional status was significantly associated with sedentary behavior, recreational screen time exceeding 2 hours per day, physical activity category, breakfast frequency, dinner frequency, fast-food/snack consumption, delayed meal pattern, and selected sociodemographic factors. Screen time showed the clearest association with overweight/obesity. However, because of the cross-sectional design and use of unadjusted chi-square analysis, the findings should be interpreted as associations rather than causal effects. Future studies should use probability sampling, validated dietary and activity tools, clearly defined WHO BMI-for-age Z-score categories, and multivariable regression analysis to identify independent predictors of childhood overweight and obesity. School- and family-based interventions should focus on limiting recreational screen exposure, encouraging regular physical activity, improving meal routines, and reducing frequent intake of energy-dense fast foods and snacks.

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